

How to Scale Microgrid Deployments?

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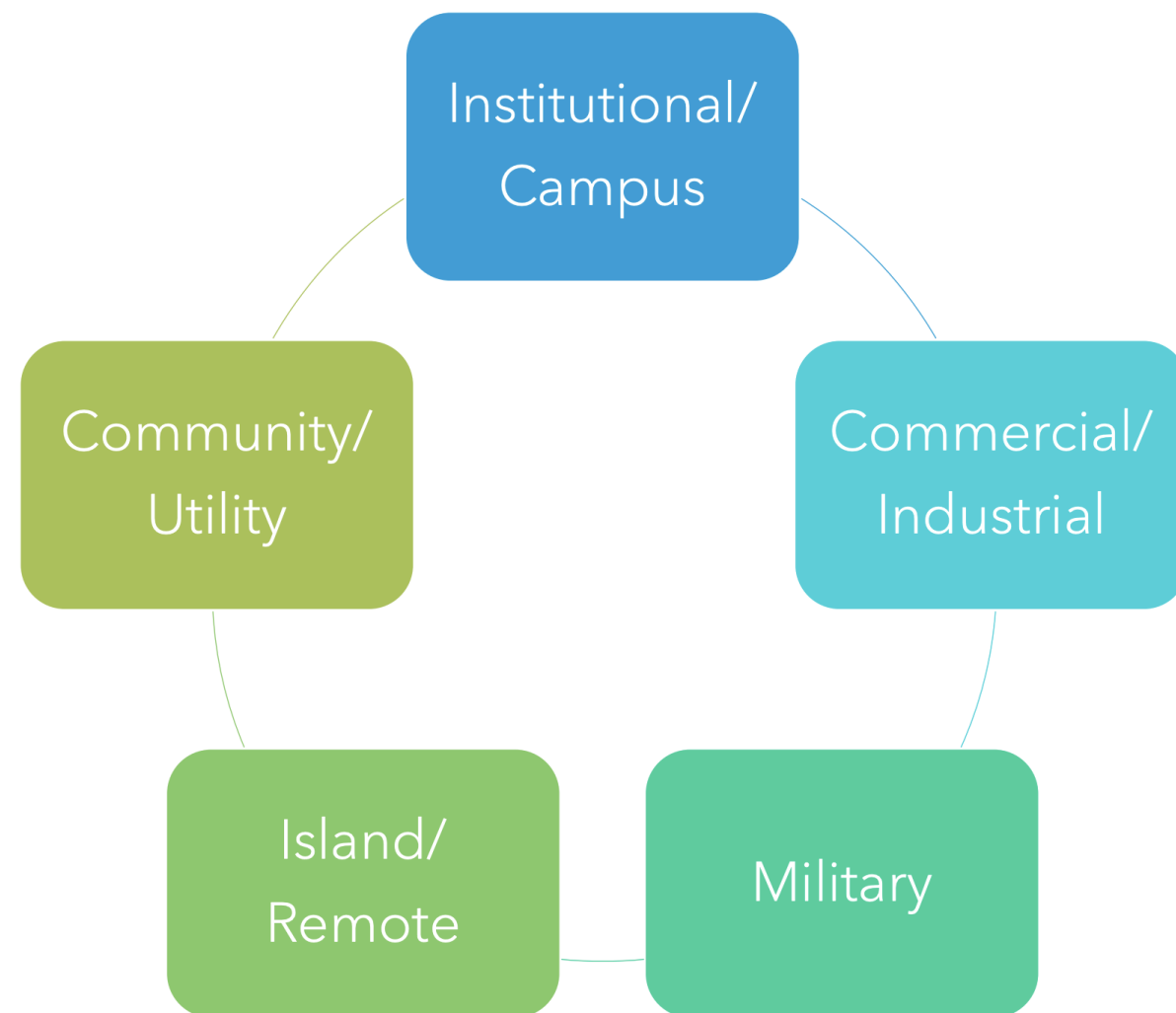
Talk partly based on “Challenges that Deter Microgrid Deployment”, Lizzy Kolar, Oluwaseyi Olaleye, Paul Walter & Raymond Zhen. Stanford B&W Tech Report 2020 and “Stanford Community Microgrid Design”, Arnab Chatterjee and Caitlin Jaeggli. Stanford B&W Tech Report 2020.

Significant practical barriers to scale microgrids

- Out of 187 microgrid developers, only **6%** completed five or more microgrids (Greentech Media, 01/2020)

What is a Microgrid?

- A **localized group** of electricity sources and loads that typically operates **connected** to and **synchronous** with the traditional centralized grid, but can **disconnect** and maintain operations **autonomously** as physical and/or economical conditions dictate (**island-mode**)



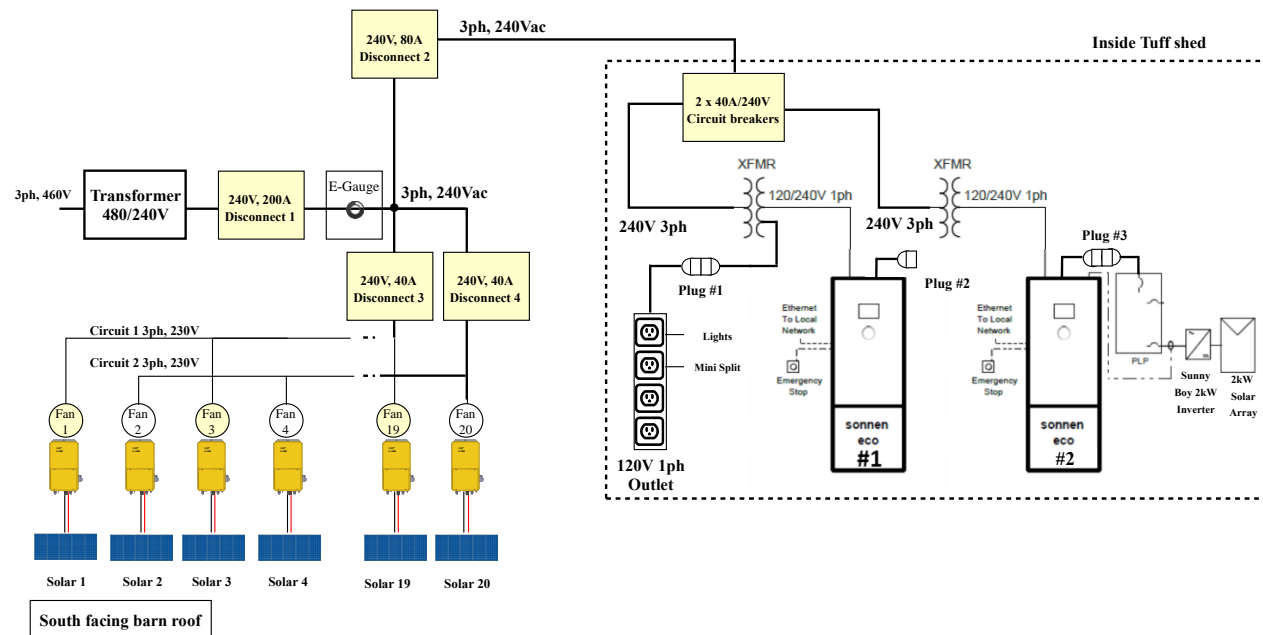
What are key design criteria?

- Costs and incentives
- Revenues
- Time to deploy
- Days of autonomy
- Emissions
- ...



Deploying Powernet in a Farm

- Dairy farms power consumption
 - 50kW per barn
 - Cooling costs \$100-\$150k/year

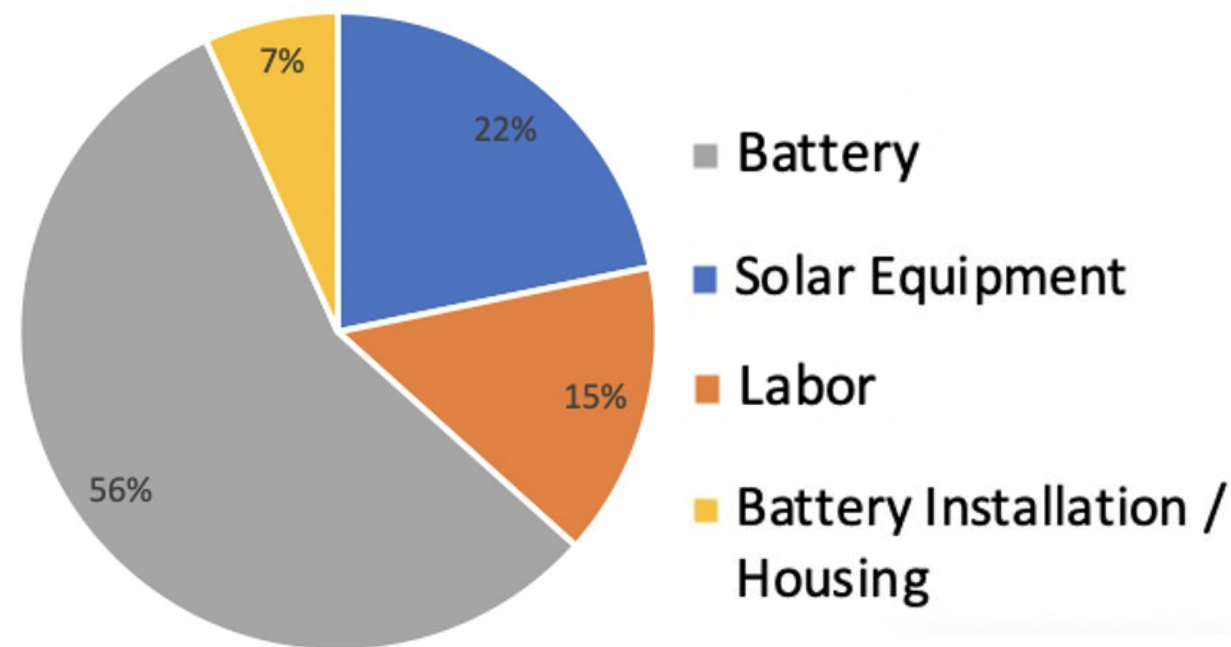


- Powernet system for barn
 - Solar offsets summer consumption
 - Direct load control
 - Battery 32kWh capacity
 - IOT sensors
 - System coordinated via cloud

Powernet at Farms: Challenges

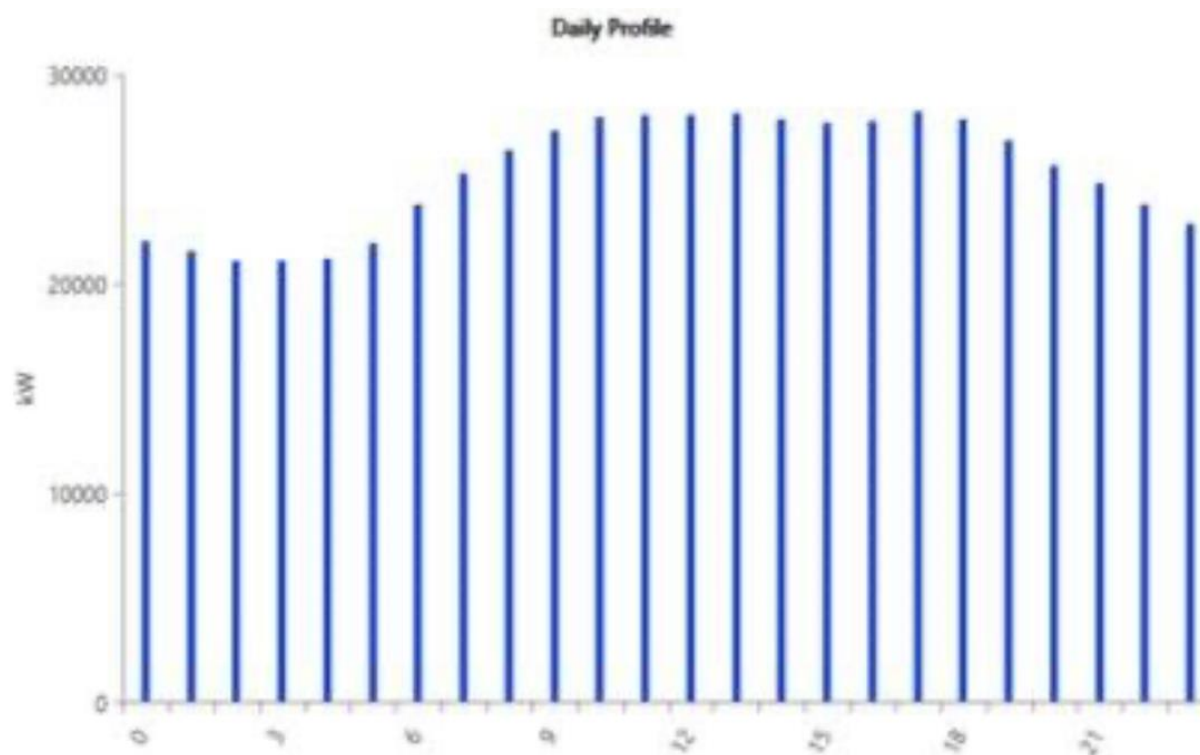
- Complex system integration of IOT sensors, inverters, load controllers and weather station
- Balancing a three-phase system solution remains a challenge
- Six months to deploy and debug
- Outage support would require additional coordination and switching
- Total system integration cost including controls was 22% (30%+ in the future)

System Costs



Designing a Microgrid for Stanford

- Design a microgrid solution to support 3-day campus islanding
- Prioritize costs and low emissions



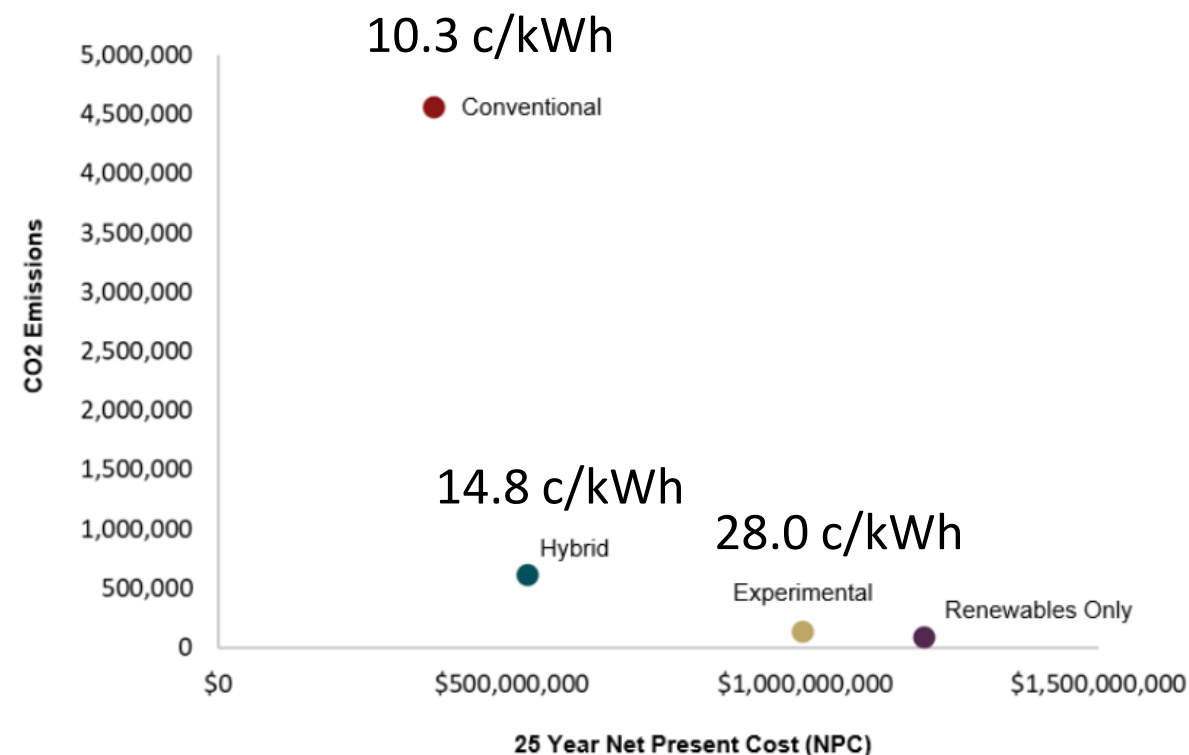
- 30 MW buildings
- 10 MW cooling/heating facility
- Existing backup diesel generation 3.7MW

Stanford Microgrid: Options

- Explore design options (Homer)

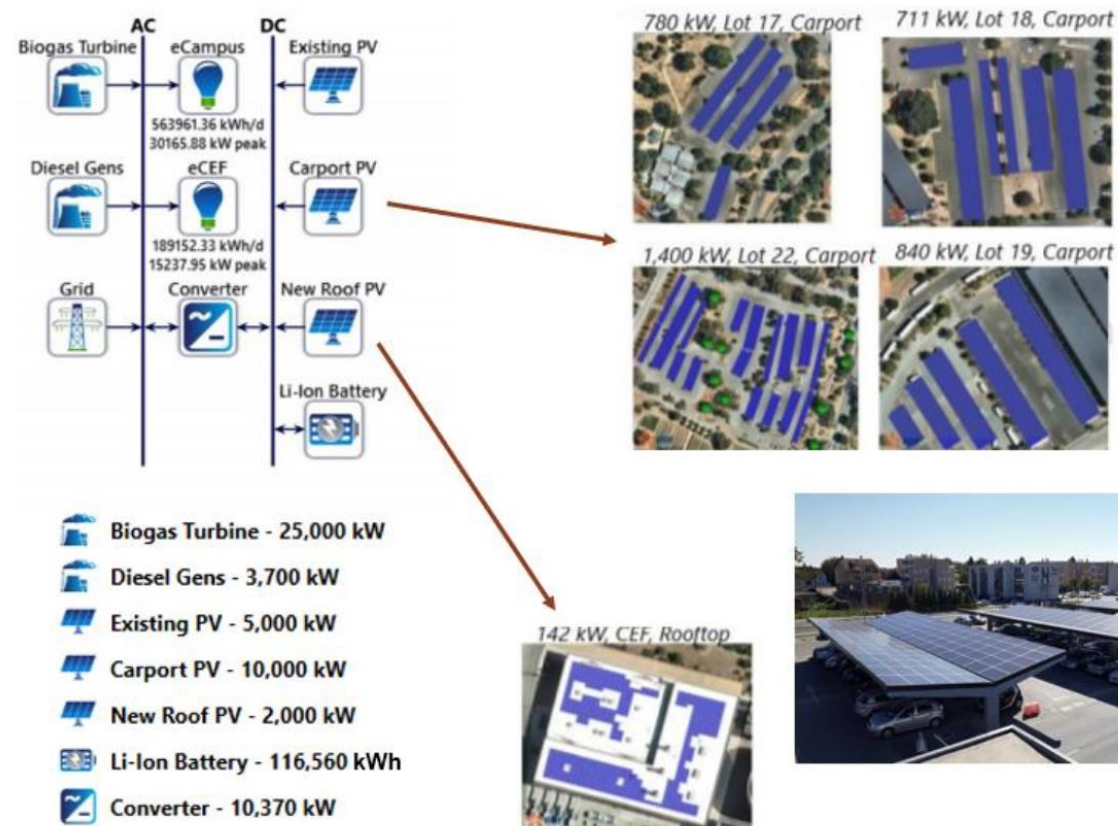
	Conventional	Hybrid	Experimental
<u>Generation in MW</u>			
<u>Conventional Generation</u>			
Existing PV	5	5	5
New Roof PV	0	2	2
Carport PV	0	10	10
Diesel Generators	4	4	0
Natural Gas Turbine	35	0	0
Total Conventional Generation	44	21	17
<u>Experimental Generation</u>			
Biogas Turbine	0	25	20
Dish PV	0	0	22
Other New PV	0	0	0
Vertical Wind	0	0	5
Hydrogen Fuel Cells	0	0	5
Total Experimental Generation	0	25	52
Total Generation Capacity	44	46	69
Li-Ion Battery (MWh)	0	117	483

Cost vs Emissions

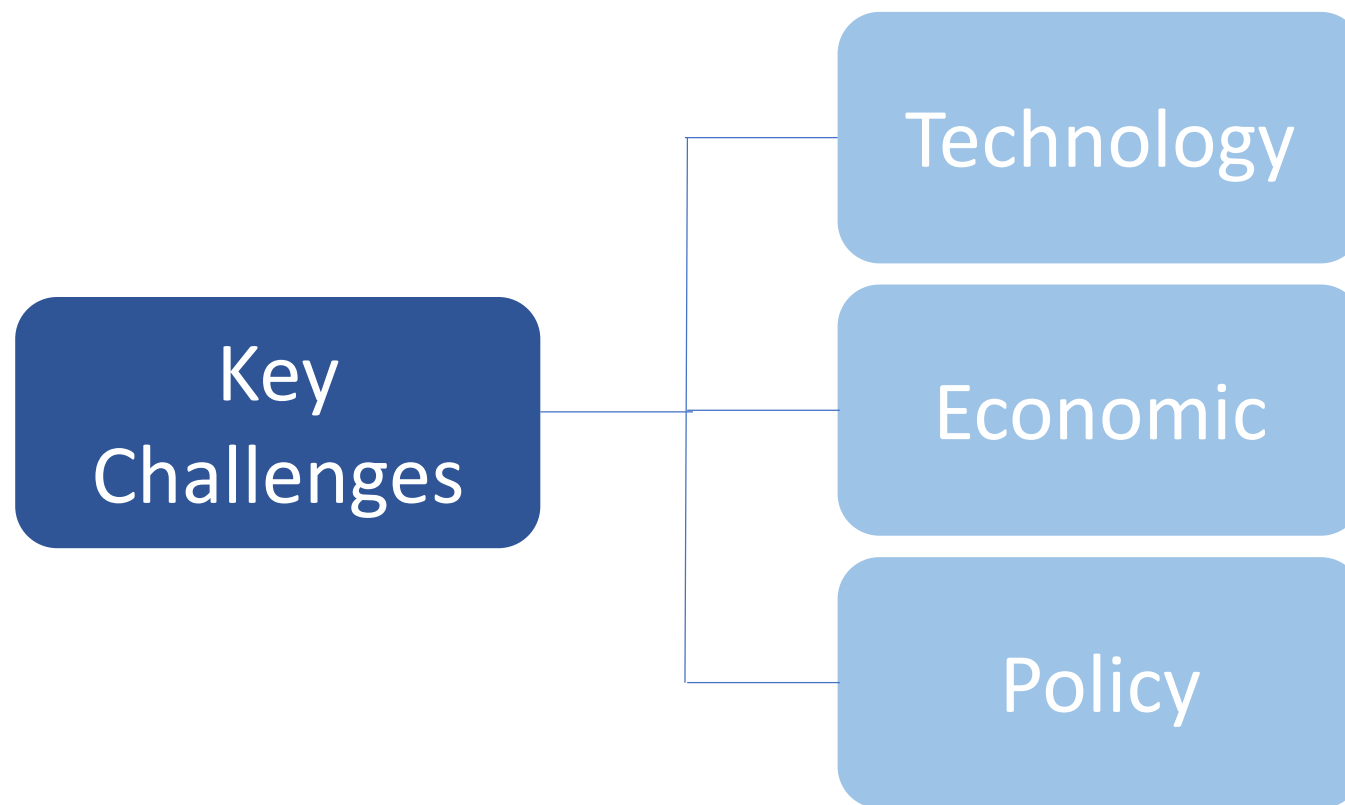


Stanford Microgrid: Challenges

- Integration costs ~30% and > 1 year permitting and build time required
- Coordination of 3.7MW of Diesel Generators and individual building switches very challenging
- Limited ability to explore scenarios that include integration with markets and stabilization



Summary



Technology Challenges: Integrating Devices Across Vendors and Technologies



Greenfield

Brownfield

- Standards exist (e.g. IEEE 2030.7)
- Incentives to integrate across providers?
- Integration with the cloud?

Technology Challenges: Integrating Devices Across Vendors and Technologies

- Standards exist (e.g. IEEE

Modularization and Standardization realizable?

Brownfield

- Integration with the cloud?

Technology Challenges: Interfacing with the Grid

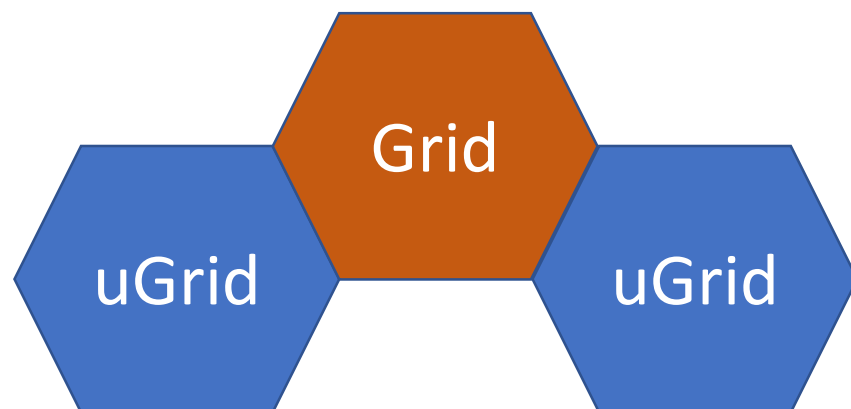
Islanding Mode

Break before
make

Make before
break

- Managing power flows
- Synchronization of devices
- Outage readiness and prediction
- Inertia

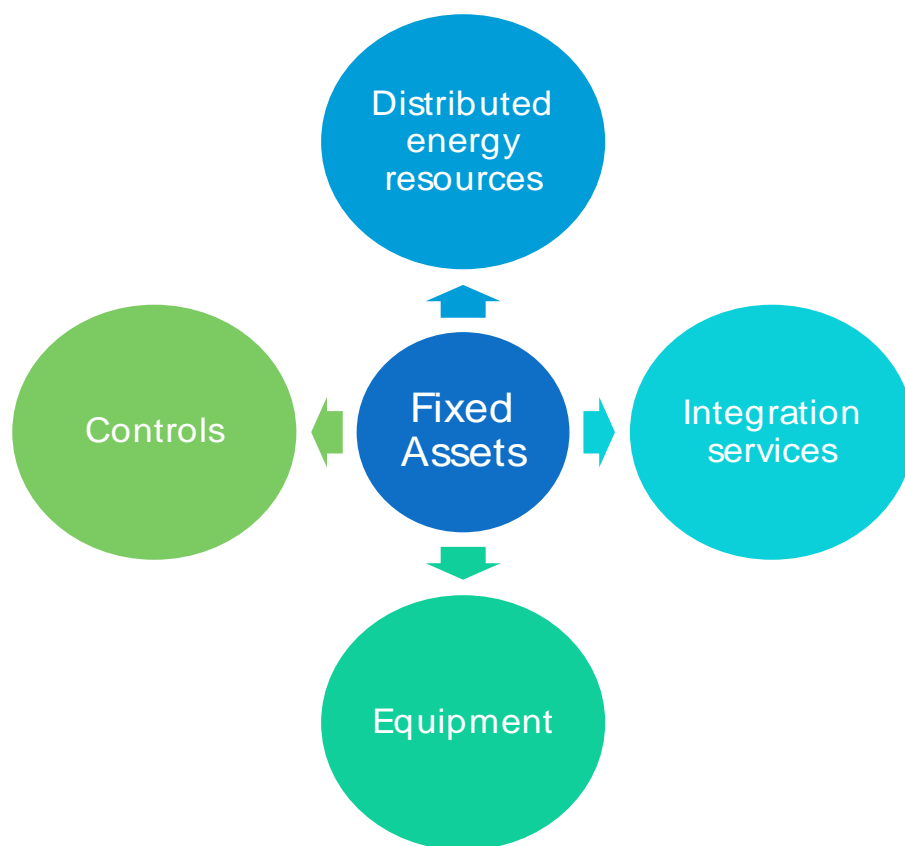
Coordination



- Co-optimizing assets
- Managing network constraints
- Marketplace

Economic Challenges

- Costs



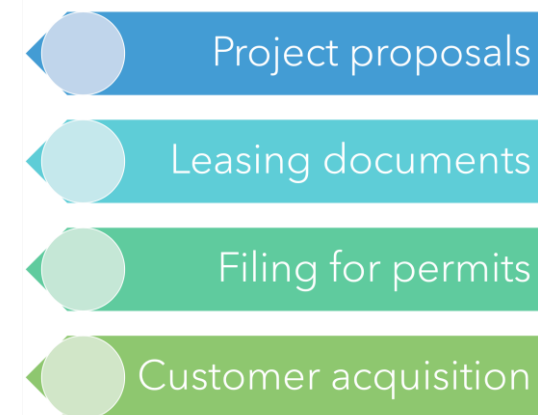
- Uncertainty of Revenue

Federal/grant partnerships

Heavy upfront capital

Value of Resiliency

- Time Horizon



Policy Challenges

- Net metering
- Zoning, permitting and compliance
- Funding availability

New York: only 5 of 64 counties eligible



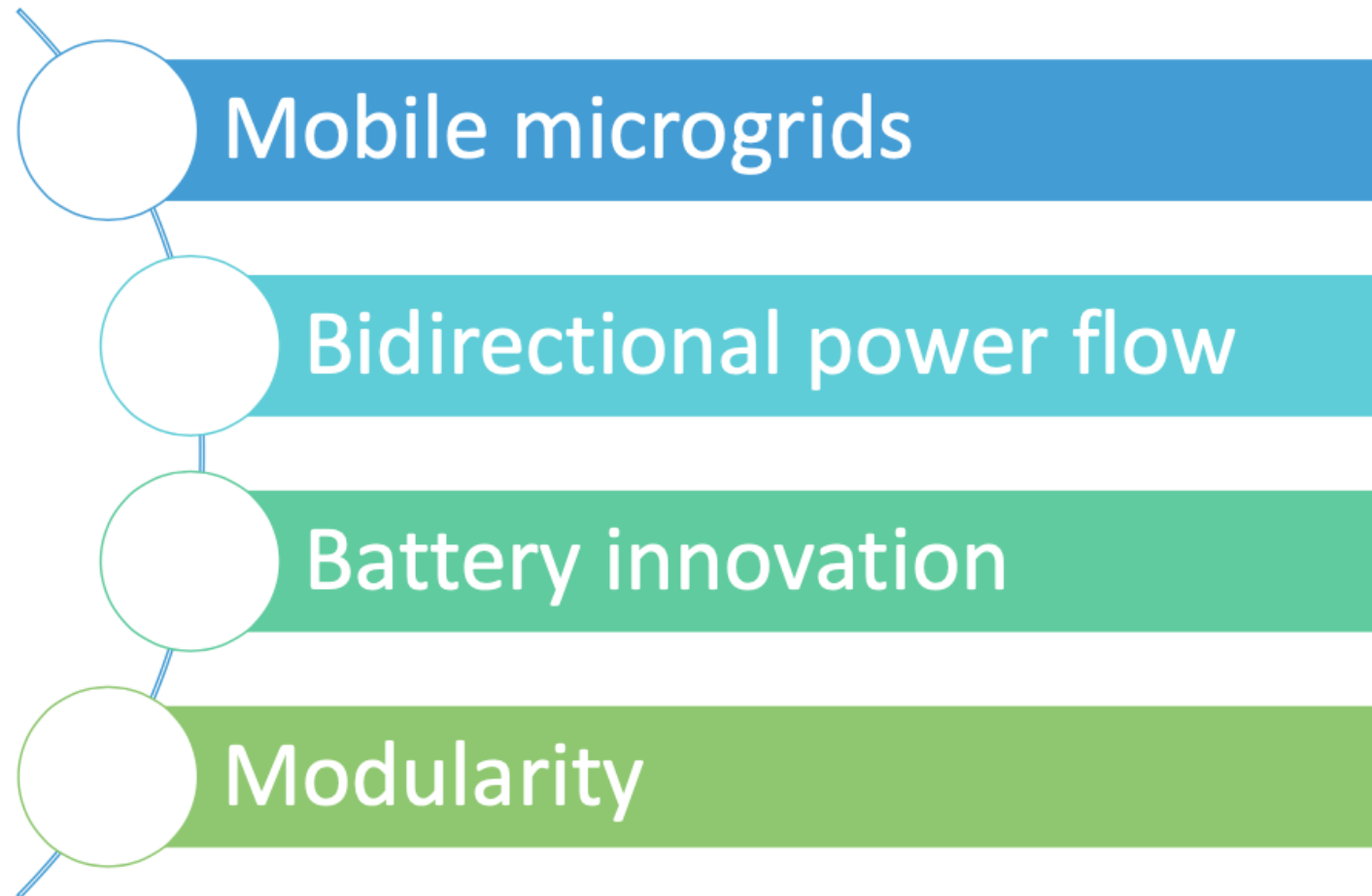
R&D



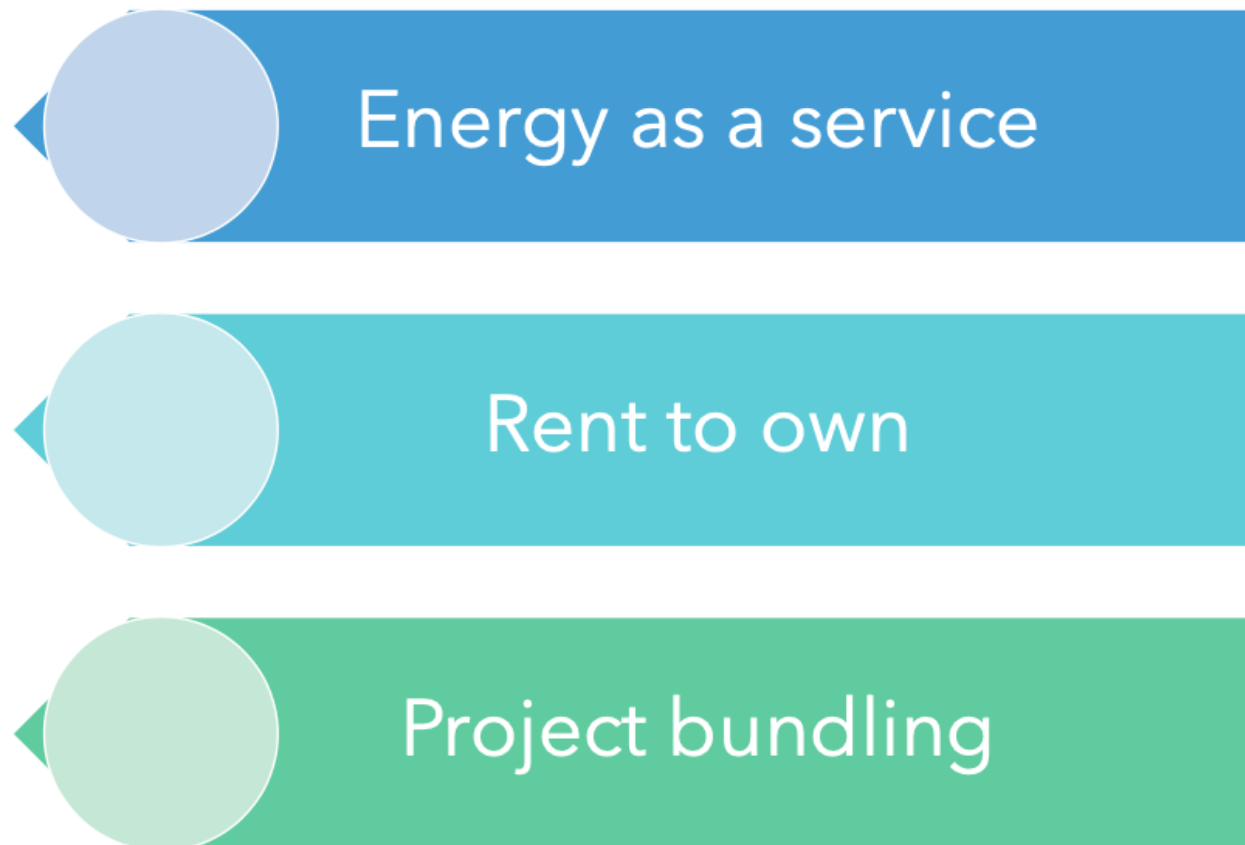
Go to market

Innovation in Technology

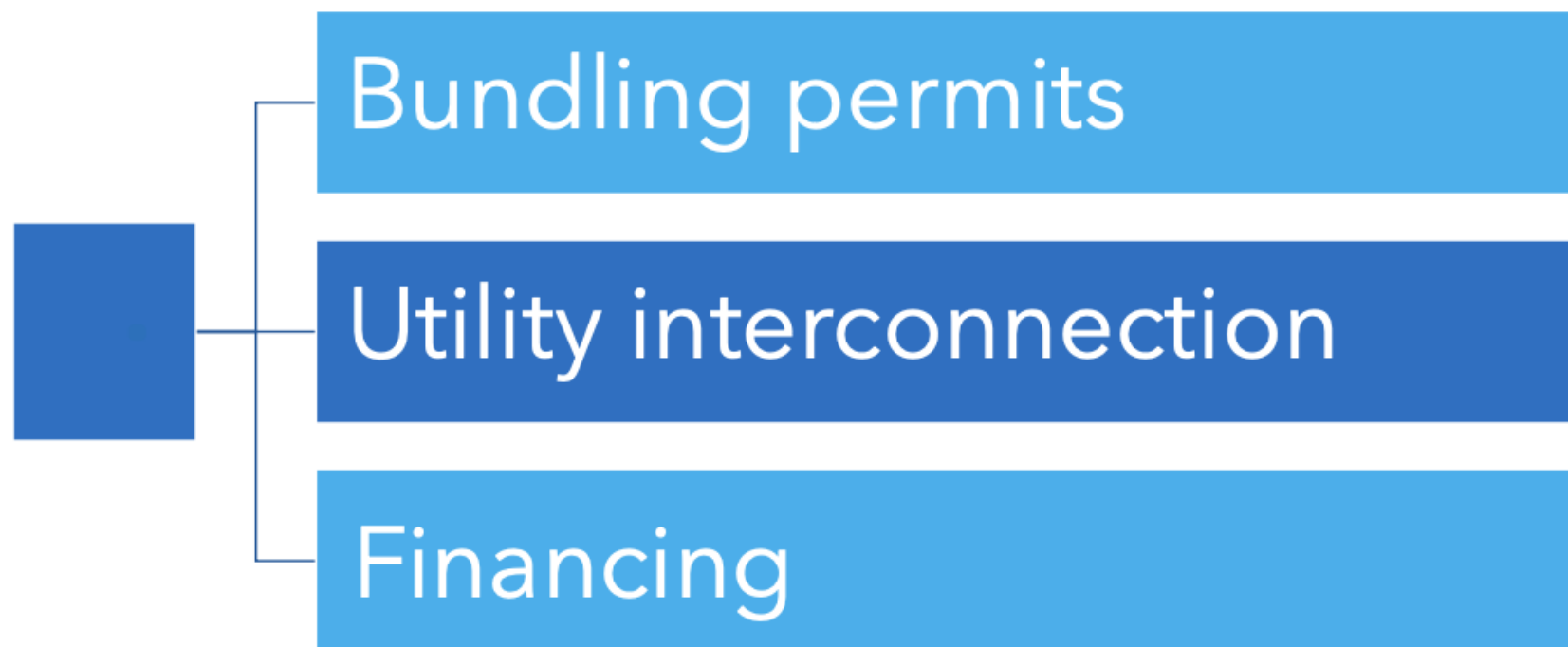
- System integration via cloud coordination



Innovation in Business Models



Innovation in Regulation



Questions?